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Ten years of research and policy on particulate matter air pollution in hot spot Flanders

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ABSTRACT

Air pollution is a systemic risk embedded in environmental, political, social and economic systems. Risk assessments on air pollution therefore involve communication between several stakeholders at multiple scale levels. This study focuses on a small part of the risk assessment, evaluating actions or decisions on both policy and research fields using an importance-performance/feasibility analysis as a scoring methodology. Subsequently, results were discussed by researchers and policy makers at a closed workshop to guarantee a safe place for knowledge integration. Learned aspects and new insights are useful for future scenarios on air pollution. This study was performed in Flanders, the European hot spot for air particulate matter. After 10 years of policy efforts in Flanders, the daily air particulate matter PM10 standard, which was enforced by the European Commission (EC) in 1999, is still being exceeded more times than allowed. No exemption for not achieving this standard was granted by the EC. What went wrong on policy and research fields in Flanders and how can this situation be prevented in the future taking into account the new PM2.5 standard that will be implemented in 2015 (European Directive 2008/50/EC)? Results of the importance-performance/feasibility analysis on actions related to PM research and policy in Flanders and discussions at the workshop, improving the communication between researchers and governmental stakeholders, are looked at.

1. Introduction

Many environmental health risks, e.g. health risks related to air pollution, are systemic in its nature: embedded in a wider environmental, social, economic and political context (Renn, 2005). Consequently, those risks are characterized by the complexity of many different, interlinked and non-linear cause-effect relationships, long-term health effects due to cumulative exposure to different agents, limited scientific knowledge, no restrictions in time or scale, an unclear sense of all consequences and/or cumulative impact of collective action. Funtowicz et al. (1999) distinguish two key properties of complexity: radical uncertainty and a plurality of legitimate perspectives or stakes. These insights of complexity generated new ideas about science and knowledge by rethinking the modern positivistic epistemological approach characterized by rationality, full knowability and disciplinary reductionism. Funtowicz and Ravetz (1990, 1993) launched the concept ''Post-Normal Science'' legitimating a plurality of knowledge and focusing on the quality of the processes as much as on the product (the universal truth) itself in the case of complex risks. To realize these ideals, post-normal science calls for partici-

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pation and open dialogue on strength and relevance of knowledge in extended peer communities taking into account researchers and stakeholders, expert – and lay knowledge. The post-normal character of air pollution is confirmed by the ACCENT Network of Excellence coordinating atmospheric research to air pollution and climate change in Europe (Pereira et al., 2009). On a more operational level, it is increasingly recognized that these systemic risks need to be addressed in a whole system approach incorporating different scientific disciplines and the involvement of stakeholders (Knol, 2010). In this perspective, frameworks for integrated environmental health impact assessments (IEHIA) are developed (Bridges, 2003; Briggs, 2008). IEHIA is described by Briggs (2008) as "a means of assessing health-related problems deriving from the environment, and health-related impacts of policies that affect the environment, in ways that take account of the complexities, interdependencies and uncertainties of the real world". IEHIA requires or has the possibility to achieve a collaboration of different groups of stakeholders across different disciplines at multiple scale levels and has the potential to change (institutional) practices. Problem definition, uncertainty management and stakeholder involvement are three key aspects of an IEHIA. The present study focuses on a small part of such an integrated health impact assessment process. The scope was to build a platform to evaluate policies or decisions on environmental health related risks by researchers and policy makers for use in future scenarios. This was worked out in a case study of air pollution by particulate matter (PM) in Flanders, the Western European hot spot for PM (IIASA, 2010). This situation is caused by a high population density, an intense industrial and agricultural activity and a large volume of transit traffic linked to important harbours. A decade ago, the European Commission enforced a PM10 (particles with an aerodynamic diameter $< 10\ \mu m$) standard (1999/30/EC) to reduce air pollution by particulate matter in order to protect public health. To meet this standard, the Flemish government has taken actions, however with little success. The daily PM10 standard is still being exceeded more times than allowed in Flanders. The exemption from obligation to apply the daily PM10 standard

Table 1 – European commission directives on air pollution by particulate matter and detailed policy implementation in Flanders.

Date	Chronology of policy on air pollution by particulate matter	
	EC directives air quality	Flemish policy action/observation
1996	Directive 96/62/EC on ambient air quality Foundation of common air quality policy within EU 4 daughter directives; air quality standards for 13 pollutants	
1999	Standard for PM10; 1ste daughter directive (1999/30/EC) Daily average PM10 concentration of 50 $\mu g/m^3$ can max be exceeded 35 times on a yearly basis; Yearly average PM10 concentration may not exceed 40 $\mu g/m^3$	
2002		Daily average PM10 concentration of 50 $\mu g/m^3$ more than 35 times exceeded on a yearly basis in Flanders
2004		Flemish plans (measures) to improve air quality submitted to EC
2005		Air quality plans approved (action plan for PM hot spots; action plan for Antwerp harbour)
2006		Premium on soot filter for lorries Reformation of traffic taxation proposed
2007		Speed reduction limit on motorways during smog episodes
2008	Directive + first three daughter directives revised and included in air quality directive 2008/50/EC Standards for PM10 preserved Standard for PM2.5 added Yearly average concentrations of PM 2.5 In 2010: target concentration of 25 μg PM2.5/m^3 In 2015: standard concentration of 25 μg PM2.5/m^3; ECO (Exposure Concentration Obligation) of 20 μg PM2.5/m^3 in urban background areas In 2020: target concentration of 20 μg PM2.5/m^3	
2008		Exemption from obligation to apply PM10 limits submitted Cooperation agreement with local authorities (sensitization, environmental check, . . .)
2009		Exemption from obligation to apply PM10 limits not approved for Belgium (2nd of July 2009); PM10 standard has to be applied in 2011 Air quality standards not achieved Reformation of traffic taxation? Standards for soot emission of private cars Start PM2.5 measurements as average exposure indicator

was not approved by the EC for Belgium, as certain proposed measures (low emission zones, road pricing) were not considered and others were not sufficiently quantified. Exposure to particulate matter is associated with strong adverse health effects (Dockery et al., 1993; Pope et al., 1995). Because of the high population density and the failure to comply with the European PM10 standard (1999/30/EC), the impact on public health is large. On average one healthy life year is lost on a lifetime basis due to exposure to air particulate matter in Flanders (Van Steertegem, 2009). This study aimed at improving the communication between policy makers and researchers in order to reduce air pollution by particulate matter and improve public health in the future. Therefore, the study used a kind of backcasting scenario focusing on 10 years of policy and research on PM10 in Flanders (Table 1) to create a platform for decisions for achieving the European PM2.5 (particles with aerodynamic diameter $< 2.5\ \mu m$) standard in 2015 (air quality directive 2008/50/EC). Backcasting is a method by which, on an environmental domain, routes for a certain future scenario are worked out by reasoning backwards on a step-by-step basis. Backcasting studies typically aim at providing policymakers with images of the future as a background for opinion forming and decisions (Dreborg, 1996; Hisschemöller et al., 2001).

Goals of this study were to (a) promote the interaction between researchers and policy makers engaged in the domain of air pollution at present, (b) synthesize lessons learnt from PM10 and how to apply these for PM2.5, (c) create a safe space to extend the relations between research and policy for future scenarios. This last issue was a practical application of the recommendations given by Pereira et al. (2009). A ''safe and authorized place'', i.e. a regular forum, where researchers and policy makers can engage in constructive dialogue and consolidate collective trust is necessary for knowledge integration.

2. Methods

In order to create a safe place for research policy interaction (Pereira et al., 2009), a closed workshop with a restricted number of selected key players active in the Flemish region (researchers and policy makers) was set up to debate on past/future policy actions related to particulate matter air pollution and research development. Policy makers were selected on the basis of their prominent role in the preparation of policy measures and in the monitoring of air pollution. The researchers who participated were active in policy supporting research, funded by the Belgian federal or Flemish government. The debate was structured by actions that were scored in advance by an importance-performance analysis.

The importance-performance analysis tool is an evaluative technique used in several disciplines. It was developed by Martilla and James (1977) as a tool to aid management in making marketing decisions. A feature that makes importance-performance analysis an explicit evaluative tool is that results can be displayed graphically and information can be communicated in a clear way. The first step in importance-performance analysis involves developing a workable list of actions. Therefore, in-depth interviews and written consultations of several policy makers as well as researchers active in the air pollution domain were carried out. The use of in-depth interviews is a usual practice in qualitative social research (Burgess et al., 1998; De Marchi et al., 1998). Out of these interviews and consultations, 40 actions related to PM policy or knowledge development were distilled. These actions were introduced in an internet poll. The internet questionnaire was preceded by a cover letter in which the goal of the study was explained and an example of scoring was illustrated. Actions were rated by a 5 point Likert scale (equally proportioned) in terms of importance for achieving the PM10 standard, importance for developing knowledge and their performance (for past issues) or feasibility (for future issues) (Fig. 1). The classic importance-performance analysis (Alberty and Mihalik, 1989) was thus extended towards an importance-performance/feasibility analysis. Different quadrants of the graphically displayed analysis may be labelled as e.g. ''concentrate here'', ''keep up the good work'', ''low priority'', ''possible overkill'' and this in terms of importance for achieving the PM standard or knowledge development on PM.

In total 10 respondents (with equal numbers of policy-makers and researchers) were invited to fill in the internet poll. The number of participants was restricted in order to promote open discussions at a following workshop, where results of the poll were presented. Descriptive statistics were performed to analyse the results of the poll. The mean and standard deviation of the answers were calculated. There is a concern regarding the use of the mean, however several scientists support its use (Borgatta, 1968; Labowitz, 1967). Clason and Dormody (1994) showed that in 54% of the articles with a Likert

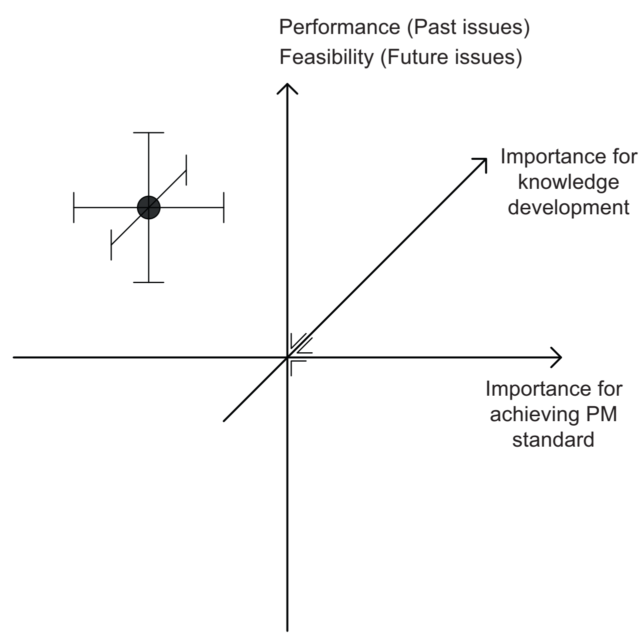

Fig. 1 – Schedule for importance-performance/feasibility analysis, by which different actions related to air pollution research and policy in Flanders were scored via an internet poll. Results were subsequently discussed at a following safe workshop place. Errors bars indicate the standard deviation.

scale method, reported in the journal of agricultural education, means and standard deviations were calculated. Knapp (1990) mentioned that in the strictest propriety the descriptive statistics ought not to be used; however, in numerous instances it leads to fruitful results.

After analysis of the poll, a research policy expert workshop was organized and aimed at building, transferring and using knowledge on air particulate matter in Flanders. All participants that filled in the internet poll were invited. In detail, the workshop was setup to (a) evaluate results of the preceding internet poll on actions related to PM policy and research by an importance-performance analysis, (b) to improve knowledge on PM policy and research and (c) to promote the communication between different stakeholders. The workshop was a closed session with several key players. This approach was chosen to create a very open and inter-active forum for discussions (Pereira et al., 2009). Results were discussed in a plenary session and brain-storm moments in small groups (2 groups; mix of policymakers and researchers) were used as a creative process to break up the day gathering, and to free participants of the intimidating necessity of addressing the full audience; although the total number of participants was already limited.

3. Results

Following context or state of affairs of the Flemish air quality policy motivated the study: (a) the daily average PM10 standard was more than 35 times exceeded on a yearly basis and (b) no exemption for not achieving this standard was given by the European Commission. In this context, an internet poll, in which measures to reduce PM concentration levels or ways to develop relevant knowledge concerning pollution by the PM-fraction could be scored by importance-performance/feasibility, provided an opportunity for researchers and policymakers to express their views on the air pollution in Flanders. Results of the analysis were split up in 4 two-dimensional graphs (Figs. 2–5). Only actions with explicit

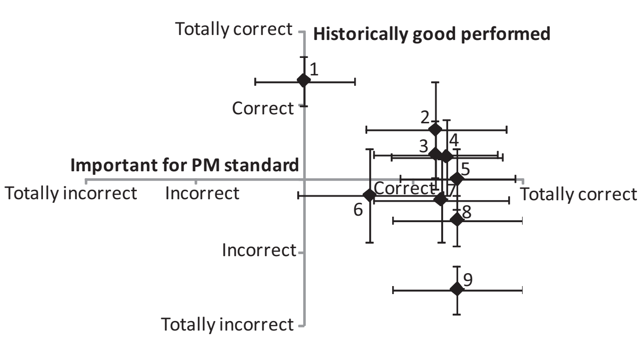

Fig. 2 – Actions of research poll scored by importance for achieving PM standard and performance in the past. Considered actions were 1: car speed reduction limit, 2: models for PM interpolation, 3: PM monitoring network, 4: PM measurements, 5: communication between researchers & policymakers, 6: coordinated research program, 7: accountability PM measures, 8: pro-active policy, 9: car taxation. Dots present the average score.

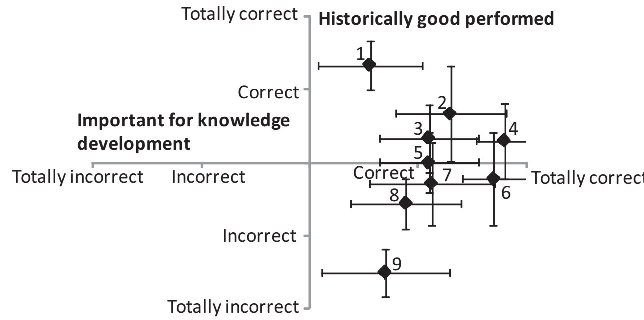

Fig. 3 – Actions of research poll scored by importance for knowledge development and performance in the past. Considered actions (1–9) are identical as in Fig. 2.

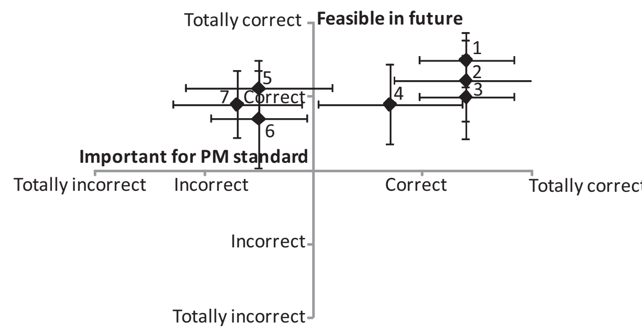

Fig. 4 – Actions of research poll scored by importance for achieving PM standard and feasibility in future. Considered actions were 1: knowledge improvement on PM sources, 2: accountability PM measures, 3: implementation low emission zones, 4: coordinated research program, 5: knowledge improvement on influence of PM composition on health, 6: tuning measures based on activity-based population models, 7: knowledge improvement on biomarkers. Dots present the average score.

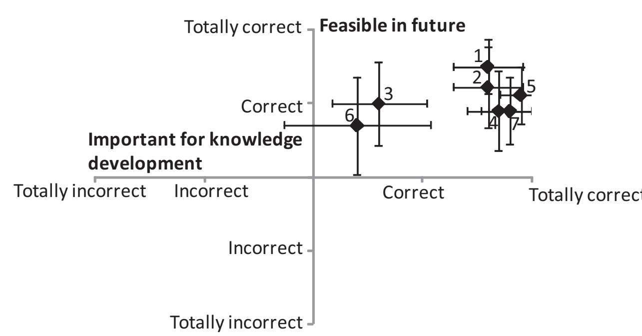

Fig. 5 – Actions of research poll scored by importance for knowledge development and feasibility in future. Considered actions (1–7) are identical as in Fig. 4.

scores or actions which were discussed at the workshop are presented. This input was used as the leitmotiv to organize the discussion at the workshop. In this section, the most important actions are presented, accompanied by observations from the workshop.

3.1. Actions scored by importance for achieving PM standard and implementation in the past (Fig. 2)

3.1.1. Air pollution measurements and monitoring network

The participants at the workshop emphasized the importance of the implemented monitoring network to measure PM concentration levels, but questions were raised about the locations of the official fixed monitoring network. In the past, monitors were located in an *ad hoc* fashion, favouring the placement of monitors in hot spots or in areas deemed subjectively to be of interest. By consequence, present locations of some measurement posts are focused on micro-situations and are not relevant for general PM exposure. Although the EU guidelines do clearly indicate that the limit values have to be respected over the entire territory, some participants felt that territory-wide PM standards ignore the relative health relevance of some PM fractions and do not adequately reflect differences in human exposure. Media and the general public focus on the location with the largest exceedance and no attention is given to the largest exposure, by which no-regret measures are hampered and no-efficient *ad hoc* measures are implemented. However, methods have been developed for locating air pollution monitors by an effective and systematic technique to maximize sampling coverage in relation to important socio-demographic characteristics, likely pollution variability and activity level (Pittau et al., 1999; Kanaroglou et al., 2005; Berghmans et al., 2009; Beckx et al., 2009; Int Panis et al., 2010).

3.1.2. Car speed reduction limit

The car speed reduction limit of 120 km h^{-1} to 90 km h^{-1} during smog episodes was scored high for its good implementation in the past, but was not seen as crucial for achieving the PM standard. A study of Dijkema et al. (2008) showed that reducing the speed limit in Amsterdam from 100 km h^{-1} towards 80 km h^{-1}, reduced PM10 concentrations significantly by 3%, relatively to a control situation without intervention. Also in Flanders the effect of the measure, by which the speed limit is reduced from 120 km h^{-1} towards 90 km h^{-1} during smog episodes (PM10 above 70 $\mu g/m^3$), had a minor effect on the PM concentration, whereas elemental carbon concentrations related to traffic decreased significantly (up to 30% near the affected motorways; Lefebvre et al., 2011). Moreover, the participants at the workshop agreed that this measure mainly serves to increase public awareness for the air pollution problem.

3.1.3. PM interpolation models

The quality of PM measurements and the application of models for interpolation of PM concentrations were scored as good implemented in the past and crucial for achieving the PM standard. Real-time assessment of the ambient air quality has gained an increased interest in recent years. To give support to this evolution, the statistical air pollution interpolation model RIO was developed in Flanders (Janssen et al., 2008). The model is classified as a detrended Kriging model. It can be used to check compliance with population exposure limit values as foreseen by the EU air quality directive. A drawback is the resolution applied in interpolation models, which makes it difficult to draw conclusions for specific locations such as street canyons. The models only give an indication of exposure but are not valid for specific locations.

3.1.4. Communication between researchers and policy makers

The communication between researchers and policy makers was scored as crucial for achieving the PM standard, but there was a rather neutral opinion on the implementation, without extreme notions or division in groups.

When risk communication is considered, literature shows that an evolution can be traced from traditional, one-way communication, to more modern, more-way communication, with a focus on participation and cooperation between researchers, policymakers and the public. The Flemish Centre of Expertise of Environment and Health incorporates risk communication in the day-to-day practice of e.g. human biomonitoring research (Keune et al., 2008).

3.1.5. Pro-active policy

Setting up a pro-active policy was scored as crucial for achieving the PM standard but the participants agreed that this was not well implemented in the past. At this moment, the problem of particulate matter air pollution is not a priority on the political agenda. This becomes evident in the poor attention given to the accountability of measures taken (see further) and the fact that Flanders is not losing any sleep over not achieving the PM10 standard. Moreover, the Flemish government established in 2006 (“Flanders in Action Plan 2020”) the ambition to become the European logistic turntable for transport. This may increase PM emissions.

The participants at the workshop identified several characteristics of a proactive policy that should be implemented in a PM hot spot area like Flanders. A pro-active policy should be based on evidence-based risk analysis and the precautionary principle should be applied in the absence of scientific consensus. This implies a transparent communication between researchers, policy administrators and policy decision makers. Measures, without resistance, should be implemented at first stage on a step by step basis, without a break e.g. the percentage of active diesel cars could have been reduced systematically, starting already 10 years ago. This would have prevented the actual burden of the high percentage of present diesels. Early input of research, cost benefit analysis, etc. in the policy cycle are therefore required. This moves the accountability issue (see further) to the front. Analysis of “What if” or “No action” or “Additional action” should be performed so that no regret measures can be taken. Another interpretation of a pro-active policy is that one should not hide oneself behind vague excuses as the inability to undo the historical land-use planning mistakes. In Flanders houses were built by a ribbon pattern which increases diffuses emissions over the whole country and requires an intensive transport network. Where cities can be heat islands, the ribbon development implies an intensive PM emission linked to heating in winter period. Another excuse often used is that the competence or power to take measures or actions related to air pollution is not Flemish but Federal or European. However, the Flemish government can take initiatives as car tax reformation, implementation of green zones or low emission zones.

3.1.6. *Car/fuel taxation*

Flanders is a transport region with still increasing traffic. In 2009, 60% of the Belgian fleet of cars consisted of diesels. This is an increase of 97% compared to 1997 (FOD Economie, 2010). This increase is partly due to the difference in fuel taxation, gasoline versus diesel. Moreover, diesel cars are promoted to reduce the impact on the climate change (largest weight factor determining car taxation is given to CO_2 emission instead of soot emission). It is noted that if soot emissions would be taken into account in the debate on climate change, it may have a large influence on the diesel-gasoline problematic in Flanders (Int Panis et al., 2002, 2004). New research shows that fine particles in the air produced by road transport trap more radiation in the earth's atmosphere than previously estimated, and therefore may contribute more to global warming than realized (Balkanski et al., 2010). Therefore it's necessary that fuel prices and the political focus on the CO_2 emission of cars are adapted.

3.2. *Actions scored by crucial for knowledge development and implementation in the past (Fig. 3)*

3.2.1. *Coordinated research program*

The most drastic change between Figs. 2 and 3 is the shift of action 6 (setting a coordinated research program) going from less important to achieve the PM standard towards highly crucial for knowledge development. In the past, a lot of fragmentary *ad hoc* research on air pollution was performed. The coordination and synchronization of research programs was not adequate. During the last decade, this has been improved by e.g. the development of focus or supporting points, indicative programs for yearly planned research projects on environment. Because these programs are yearly planned, a long term vision may be missing. If these programs would support studies on the longer term, who should determine the content, focus or accent of these coordinated studies? Policy decision makers would try to enforce their vision. There was a general consensus on the fact that cabinets act as filters so that a lot of information gets lost bottom upwards (research → policymakers → cabinets or decision makers → ministers). Policy development retains a significant amount of politicking in which the frameworks for information can only partly be systematized. There are obvious information flows between different levels and different types of frameworks. In these flows information is transformed because the frameworks are not neutral gates that only pass on information (Assmuth and Hildén, 2008). In the framework of scientific knowledge development, it remains important that researchers certainly need to engage with non-researchers, such as policy makers and civil society, to appreciate the nature of their concerns and questions (Pereira et al., 2009).

3.3. *Actions scored by crucial for achieving PM standard and feasibility in future*

Knowledge improvement on sources of PM (Riddle et al., 2008; Moreno et al., 2009), the implementation of low emission zones (LEZ) and the quantification of measures to reduce PM concentrations (accountability) are scored as crucial for achieving the PM standard and achievable in the near future.

3.3.1. *Knowledge improvement on sources of PM*

The participants at the workshop agreed on the importance to assess what the share is of different (industrial) sectors in the allocated PM fraction (who's to blame?) and to examine the formation and composition of PM. Size-resolved source apportionment of airborne particle mass in a roadside environment showed that 30% of the measured elemental carbon concentrations still have an unknown source (Riddle et al., 2008). There are still missing processes on secondary organic aerosol formation in urban air (Matsui et al., 2009). Vercauteren et al. (2011) have just published important new data on the chemical composition of PM10 samples in Flanders. This analysis is a first move in trying to get insight in the different sources of PM.

3.3.2. *Low emission zones (LEZ)*

At the workshop, there was a discussion on the implementation of low emission zones (LEZ), which was scored by the attendants as a very effective measure to obtain the PM standard. It was remarked that several political parties consider this measure as antisocial e.g. some polluting vehicle types, belonging to different socio-economic classes, may be restricted to enter a specified area. The general tendency shows that it should be possible to correct for this antisocial aspect by e.g. providing inhabitants of a LEZ a free annual ticket for public transport or providing free parking places or applying the incomes that a LEZ delivers for reducing taxes on earnings. Low emission zones are already implemented in our neighbouring countries e.g. U.K. (Kelly and Kelly, 2009). The fleet of cars in Flanders consists of a relatively large amount of diesels compared to neighbouring countries, which would render the implementation of LEZs more efficient. A recent PM10 analysis by Vercauteren et al. (2011), shows that elemental carbon has the largest relative difference between different sampling sites in Flanders, suggesting that there is potential for measures that target traffic emissions at a local scale by e.g. implementing LEZ.

3.3.3. *Accountability of measures to reduce PM exposure*

In the Commission's decision on the notification by Belgium of an exemption from the obligation to apply the limit values for PM10, it was stated that "some information on the observed and planned effects of certain measures to improve the air quality situation was not included". This means that more attention has to be given to the impact of certain measures; thereby modelling of PM air concentrations may help to predict or rather project emissions for future situations after implementation of new measures. Recent scientific research helps to develop methods to quantify the effect of policies and measures. Lumbreras et al. (2009) developed a policy instrument to design emission reductions levels for road transport. Projections for future PM air concentration levels in relation to e.g. human activities as transporting, provides a valuable contribution to establishing efficient and effective policies and measures. Recently, the Health Effect Institute (HEI) funded eight studies on accountability, which cover near-term interventions to improve air quality (Van Erp et al., 2008). These studies include e.g. measures to reduce traffic, replacing old wood stoves with cleaner ones, longer term wide-ranging actions or events (such as complex changes associated with

the reunification of Germany). Such research may contribute to estimating the burden of disease that might be avoided in the future if certain actions are taken.

3.4. *Actions scored by crucial for knowledge development and feasibility in future (Fig. 5)*

The most achievable action was knowledge improvement or development on the sources of primary and secondary PM. The most crucial action was gathering more information on the composition of PM and the effect of individual components of this composition on public health. There remains uncertainty about which chemical components of PM are most harmful to human health. Mass alone is not a sufficient metric when evaluating health effects of PM exposure (Franklin et al., 2008).

4. Discussion

4.1. *Applied method*

Initially key players, related to air pollution research or policy in Flanders, were selected. Written consultations and in depth interviews were performed to elicit information on this particular domain. Based on this knowledge, actions were distilled for an importance-performance/feasibility analysis via an internet poll. After analysis of the data, results were displayed at a workshop, attended by the small group of invoked persons. Results of the poll were used to channel the workshop and topics were openly discussed. It was not the goal to come to a consensus but each opinion was important. Benefits of the followed procedure were: (a) the creation of a safe place for information transfer to stimulate an open communication between researchers and policy makers; (b) it was a joint learning process from which results are applicable for future scenarios (air quality directive 2008/50/EC); (c) this kind of interaction yields more nuanced and precise information relevant to both science and policymaking than a scoring poll alone. The results show that the researchers and policymakers involved share attitudes, general policy recommendations and technical expertise, and that their common challenge is to get more control of the communication and information transfers to decision makers and the general public. A minor point was the time consuming process of in depth interviews, although a relationship was created which was in it turn favourable for the discussions at the workshop. On top, the method is not relevant for urgent issues, as it expects a lot of input of the key players and a meeting for discussions. Citizen participation (Renn, 2006) was not considered here.

4.2. *A new (PM) standard?*

In the poll there was a deficit between actions that were scored as important to achieve the current PM standard and actions that were scored as important for knowledge development; e.g. actions as use of biomarkers (Scecova et al., 2009; Moreno et al., 2009), tuning measures for specific target groups based on activity-based population models (Beckx et al., 2009) and the development of knowledge on the influence of PM composition on health (Franklin et al., 2008). When Figs. 4 and 5 are compared, there is a clear shift of these actions from less important for achieving the PM standard to crucial for knowledge development. These topics are currently studied by several research groups and can help with improving setting new PM standards. It should be noted that in many studies there has been no evidence of a PM threshold at which no negative effects on health occur. The WHO sets in the report on air quality guidelines that the risk for various outcomes has been shown to increase with exposure and there is little evidence to suggest a threshold below which no adverse health effects would be anticipated (WHO, 2005). In this optic, McClellan (2002) asks himself the question ‘‘how low is low enough?’’ for setting ambient air quality standards for particulate matter and argues that the focus should be on total health benefits to a society for a given cost. Recent experiences with e.g. biomarkers may help with setting a new PM standard, more based on understanding of the negative influence that PM has on biological processes. Legislation concerned only with measuring physical PM mass concentrations fail to address potential health effects linked to chemical variations in ambient aerosols (Moreno et al., 2009).

4.3. *Thin line between researcher and policymaker*

The workshop has confirmed an observation made during preparatory interviews: in the domain of air quality policy, public servants communicate well with researchers from scientific institutions. The protagonists in Flemish air quality policy have a common scientific background and are technical experts, no matter if they are working as public servants or as researchers. Indeed, the experts share the same technical references, but they play different roles. This observation puts into question a common discourse postulating that there is a ‘‘communication problem’’ or ‘‘gap’’ between researchers and policymakers, without specifying the institutional affiliation or job description of the actors covered by these categories. This discourse as a description of a state of affairs does not suit empirical reality, and needs to be reformulated in more precise terms. If there is a communication gap, it is not to be situated between public administration (policymakers) and researchers (scientists), who communicate well and share the same overall concerns, but between public administration and ministerial cabinets.

5. Conclusions

Systemic risks characterized by complexity require the collaboration between different stakeholders and the interaction on several levels. The communication exercise described in this study, included a collaboration of researchers and policy administrators and expected a large input or effort but resulted in a fruitful discussion on the policy and research topics on particulate matter (PM) air pollution in hot spot Flanders.

The exercise consisted of a research poll based on an importance-performance/feasibility analysis followed by a closed workshop to guarantee a safe place for discussion by

key players and resulted in following conclusions. The location of some present measurement posts in hot spot Flanders is not directly in function of PM sources and public exposure to PM. Some present locations are focused on micro-situations, which miss the goal of human health protection. Although EU guidelines indicate that limit values need to be respected over the entire territory, some participants felt that territory-wide PM standards ignore the relative health relevance of some PM fractions and do not adequately reflect differences in human exposure. Flanders also misses a pro-active policy and still stimulates the use of diesel cars under the guise of less impact on climate change. On top, the impact of implemented measures is not sufficiently quantified and certain measures like LEZ implementation are still lacking.

In the field of knowledge improvement, research programs on PM should be better coordinated with collective synchronization and based on a long term vision. This knowledge should be open to public in such a way that it is useful for reflecting and the preparation of PM policy and research. In detail, more research should take place to e.g. determine the sources of primary and secondary PM and gain more information on the PM composition and its influence on public health.

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